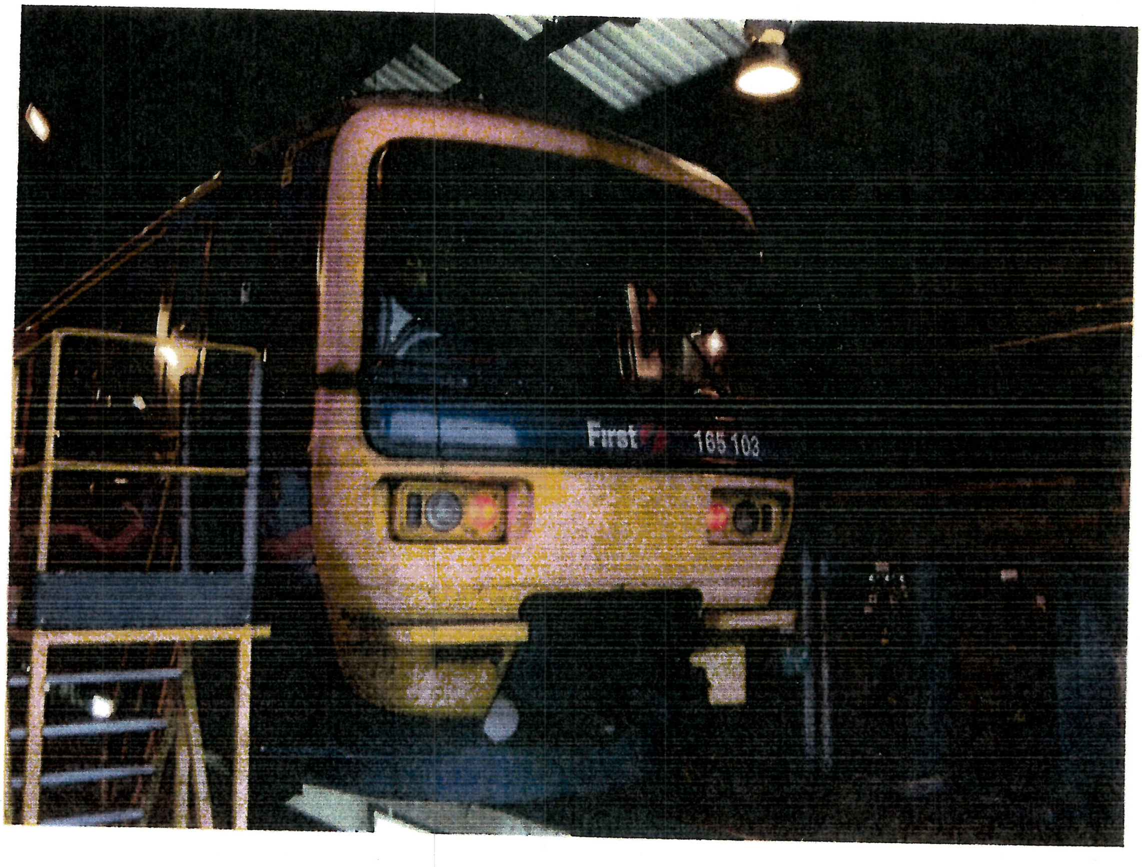
First Great Western

READING TURBO MAINTENANCE DEPOT

CLASS 165/166 TURBO

BRAKING SYSTEMS


First
165 103

INTRODUCTION TO THE
CLASS 165
BRAKING SYSTEMS

1. INTRODUCTION

The Class 165 is fitted with a Westinghouse "Westcode" braking system. This is a 3 step energise to release electro-pneumatic (e.p.) brake system and applies disc brakes to each wheel on each bogie.

Spring applied parking brakes are used to brake 1 wheel on each wheelset.

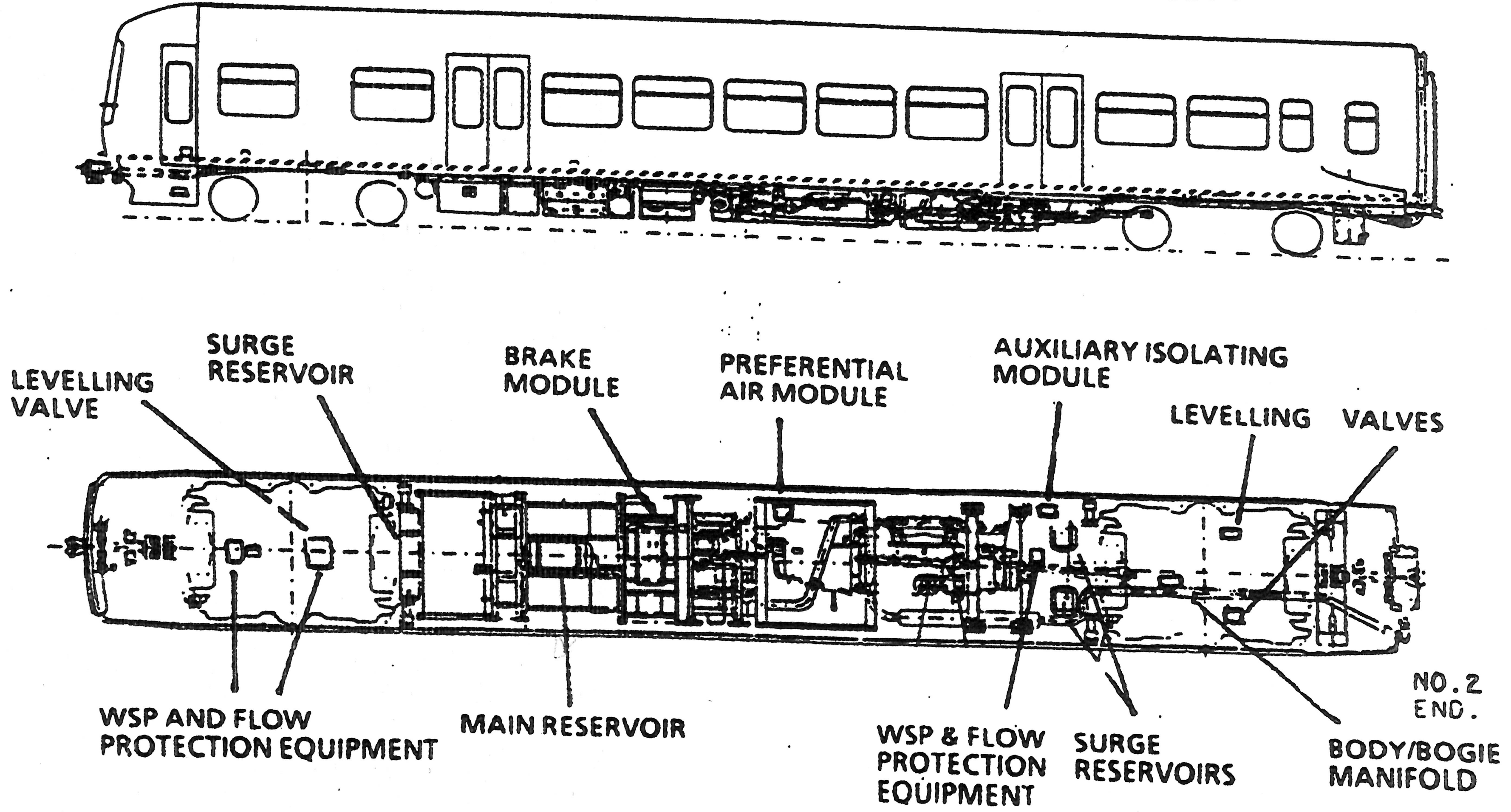
There is also a wheelslide prevention unit (W.S.P.) to prevent skidding.

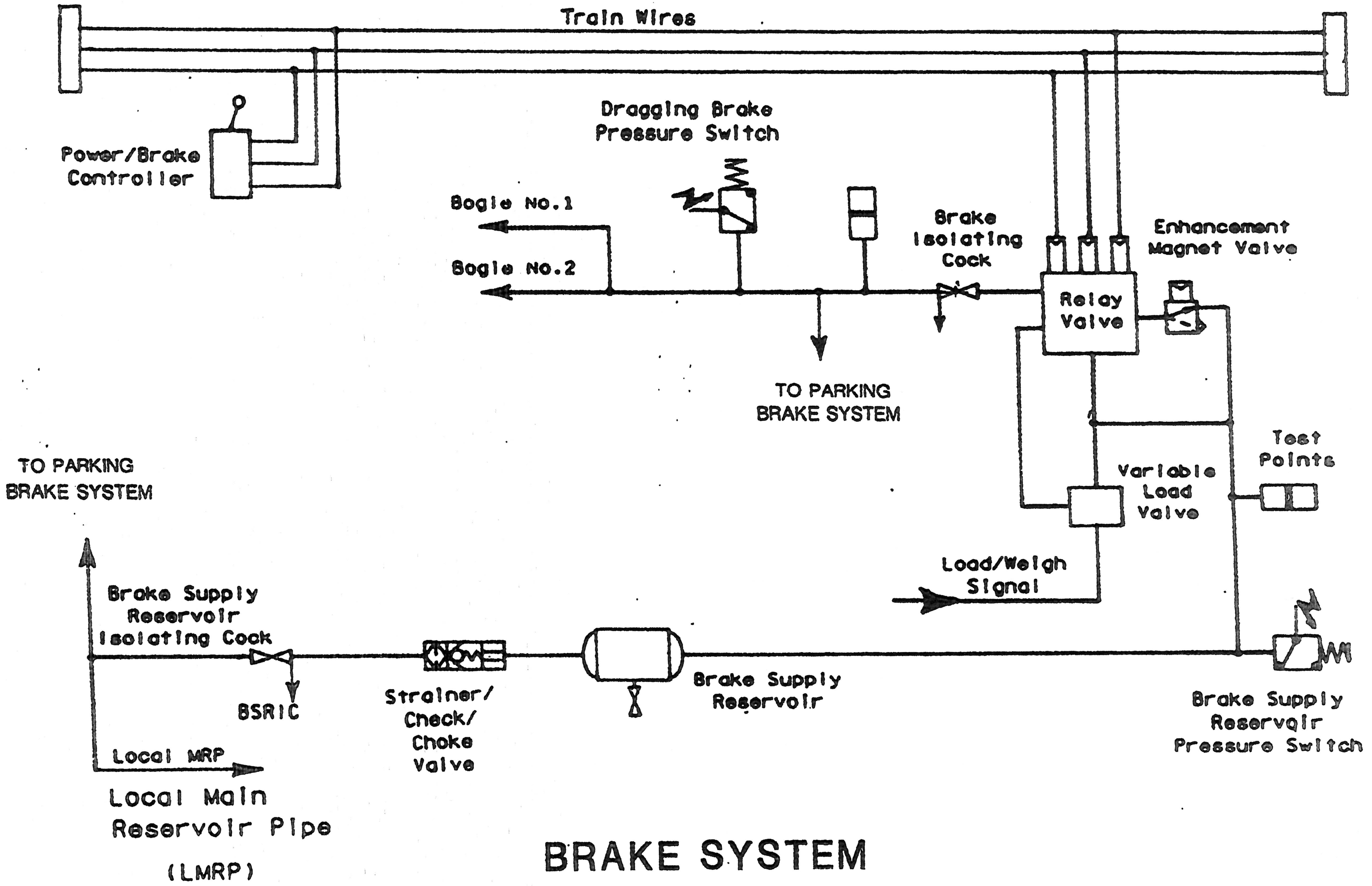
The brake system uses electric circuits to monitor the various systems on the vehicle/train that can apply the brake including movement of the power-brake controller. These circuits control the operation of a relay valve which supplies air to the brake cylinders in 4 steps. A pneumatic system of load weighing varies the brake cylinder pressure according to the number of passengers so the braking distance for each step is approximately the same regardless of the number of passengers.

There are several safety systems incorporated for driving purposes:-

Automatic Warning System (A.W.S)
Drivers Safety Device (D.S.D.)
Vigilance
and Automatic Train Protection (A.T.P.) on Chiltern Lines.

UNDERFRAME EQUIPMENT LAYOUT - DMOCL A


LEVELLING VALVE
SURGE RESERVOIR
BRAKE MODULE
PREFERENTIAL AIR MODULE
AUXILIARY ISOLATING MODULE
LEVELLING VALVES
WSP AND FLOW PROTECTION EQUIPMENT
MAIN RESERVOIR
WSP & FLOW PROTECTION EQUIPMENT
SURGE RESERVOIRS
NO. 2 END.
BODY/BOGIE MANIFOLD


Train Wires
Power/Brake Controller
Dragging Brake Pressure Switch
Bogie No.1
Bogie No.2
Brake Isolating Cock
Enhancement Magnet Valve
Relay Valve
TO PARKING BRAKE SYSTEM
Test Points
Variable Load Valve
Load/Weigh Signal
TO PARKING BRAKE SYSTEM
Brake Supply Reservoir Isolating Cock
BSRIC
Strainer/ Check/ Choke Valve
Brake Supply Reservoir
Brake Supply Reservoir Pressure Switch
Local MRP
Local Main Reservoir Pipe
(LMRP)

BRAKE SYSTEM

CLASS 165

2. BRAKES PNEUMATIC SYSTEM

The brake system is supplied with air from the local main reservoir pipe via the Brake Supply Reservoir Isolating (& venting) cock.

The air then passes through a Strainer Check/Choke Valve Unit before entering the Brake Supply Reservoir.

The Brake Supply Reservoir provides the air for the brake cylinders and maintains this facility in the event of a loss of main reservoir supply. Hence the check valve to prevent the Brake Supply Reservoir back feeding into the main reservoir pipe.

If the air pressure in the Brake Supply Reservoir was low there would be a reduction in the braking performance. Thus, a Brake Supply Reservoir Pressure Switch, monitors the reservoir pressure and if it falls below 5.5 bar applies the brakes on train. If this does occur the reason for the loss of air pressure must be ascertained and suitable action taken, by isolating defective equipment, as necessary, before operating the Emergency Brake Isolating Switch to allow the unit to move.

The amount of air supplied to the brake cylinders is controlled by the relay valve in relation to the coach weight signal provided by the variable load valve.

The enhancement magnet valve is an integral part of the brake unit and is used to compensate for losses in the brake rigging.

After the relay valve there is a brake cylinder isolating (& venting) cock. This cock isolates the standard brake cylinders but those cylinders with parking brakes also require the parking brake isolating cock to be operated to isolate & exhaust the relevant cylinders.

A dragging brake pressure switch set at 0.5 bar operates a fault light on the drivers desk if there is air in the brake cylinders when the train speed exceeds 6kph, under traction power.

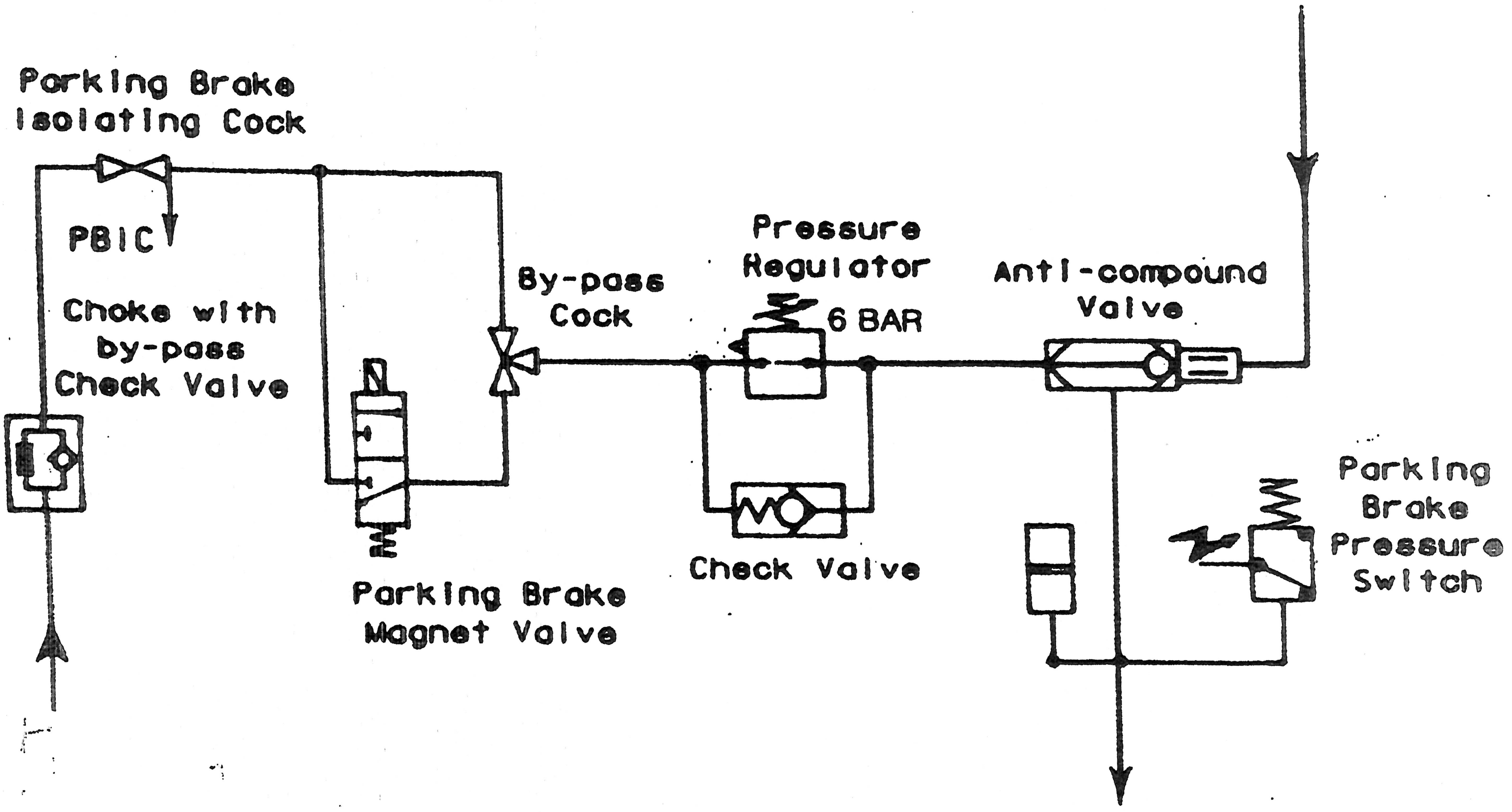
Air is supplied to each bogie by 2 parallel pipes joined at the body at the bogie by a double check valve. This arrangement automatically isolates a burst pipe whilst maintaining a brake supply.

Dump valves controlled by the WSP rack reduce the brake cylinder pressure when wheelslide occurs.

Each wheel is braked using its own S.A.B. brake cylinder which is equipped with an automatic slack adjuster. 1 brake cylinder per wheelset has a combined spring applied parking brake unit. This parking brake system is semi-automatic:

The parking brakes will not release until there is 5.5 bar in the Brake Supply Reservoir, and when the vehicle is berthed the parking brake gradually applies as the brake cylinder pressure leaks off.

PARKING BRAKE AIR SYSTEM


Parking Brake Isolating Cock
PBIC
Choke with by-pass Check Valve
Parking Brake Magnet Valve
By-pass Cock
Pressure Regulator
6 BAR
Check Valve
Anti-compound Valve
Parking Brake Pressure Switch

3. PARKING BRAKE AIR SYSTEM

Each axle on Class 165 is equipped with 1 brake cylinder incorporating a spring applied parking brake.

The spring applies the brake if there is not enough air in the parking brake air system to hold off the spring piston in the brake cylinder.

The parking brake air system is supplied from the local main reservoir pipe via a charging check valve a Parking Brake Isolating and Venting Cock. (P.B.I.C.), and a parking brake magnet valve. It is this parking brake magnet valve that usually controls the operation of the parking brake.

When the master switch is moved away from OFF an electric supply is provided to the parking brake circuits. On each vehicle if and when the brake supply reservoir pressure switch operates to indicate there is sufficient pressure in the air brake system, the magnet valve will be energised and air supplied to the parking brake air system to release the parking brakes.

Returning the master switch to off, or if the brake supply reservoir pressure switch indicates low pressure, the magnet valve will de-energise and apply the parking brake.

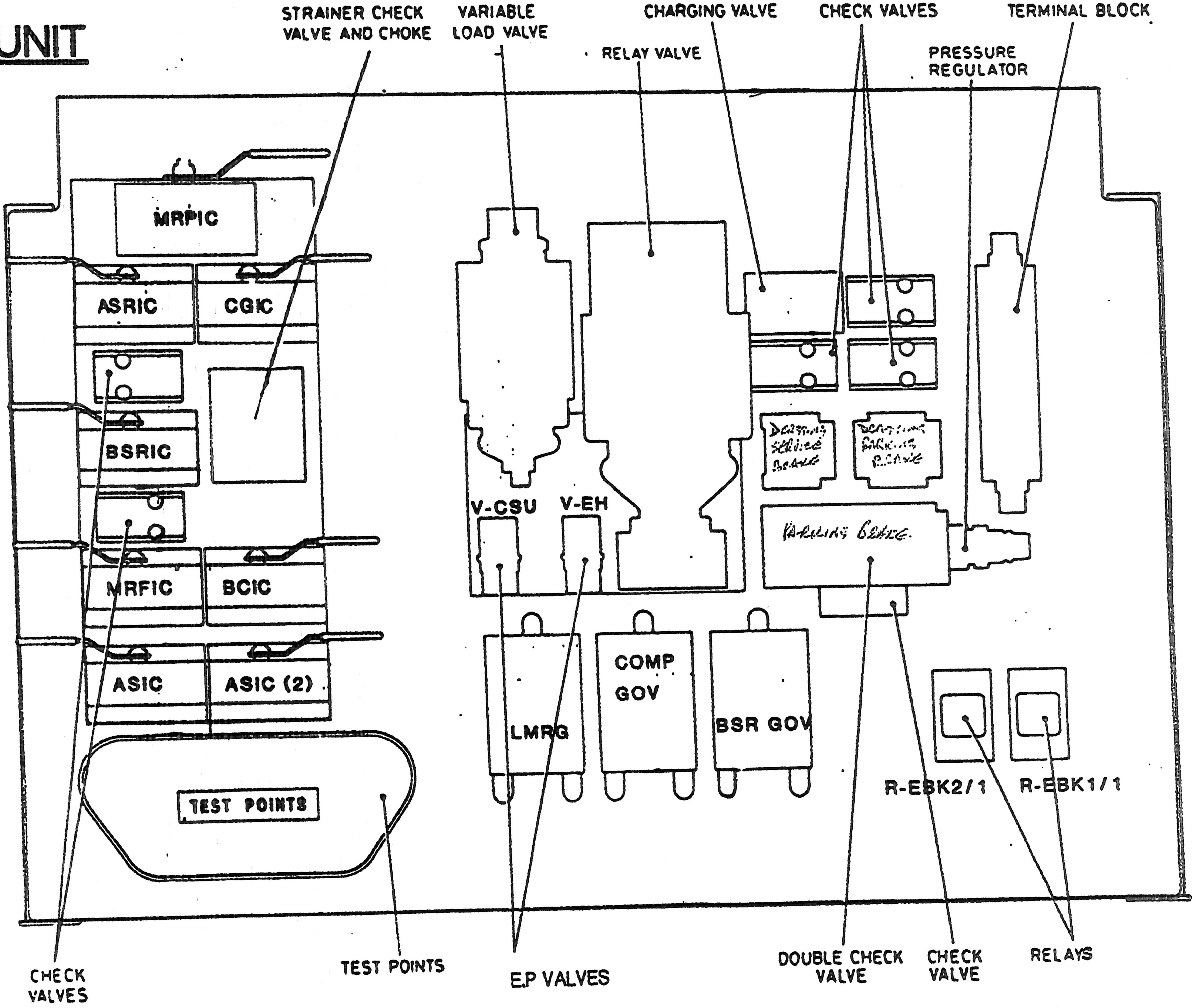
Air from the magnet valve passes through a 3 way cock to the pressure regulator set at 6.0 bar.

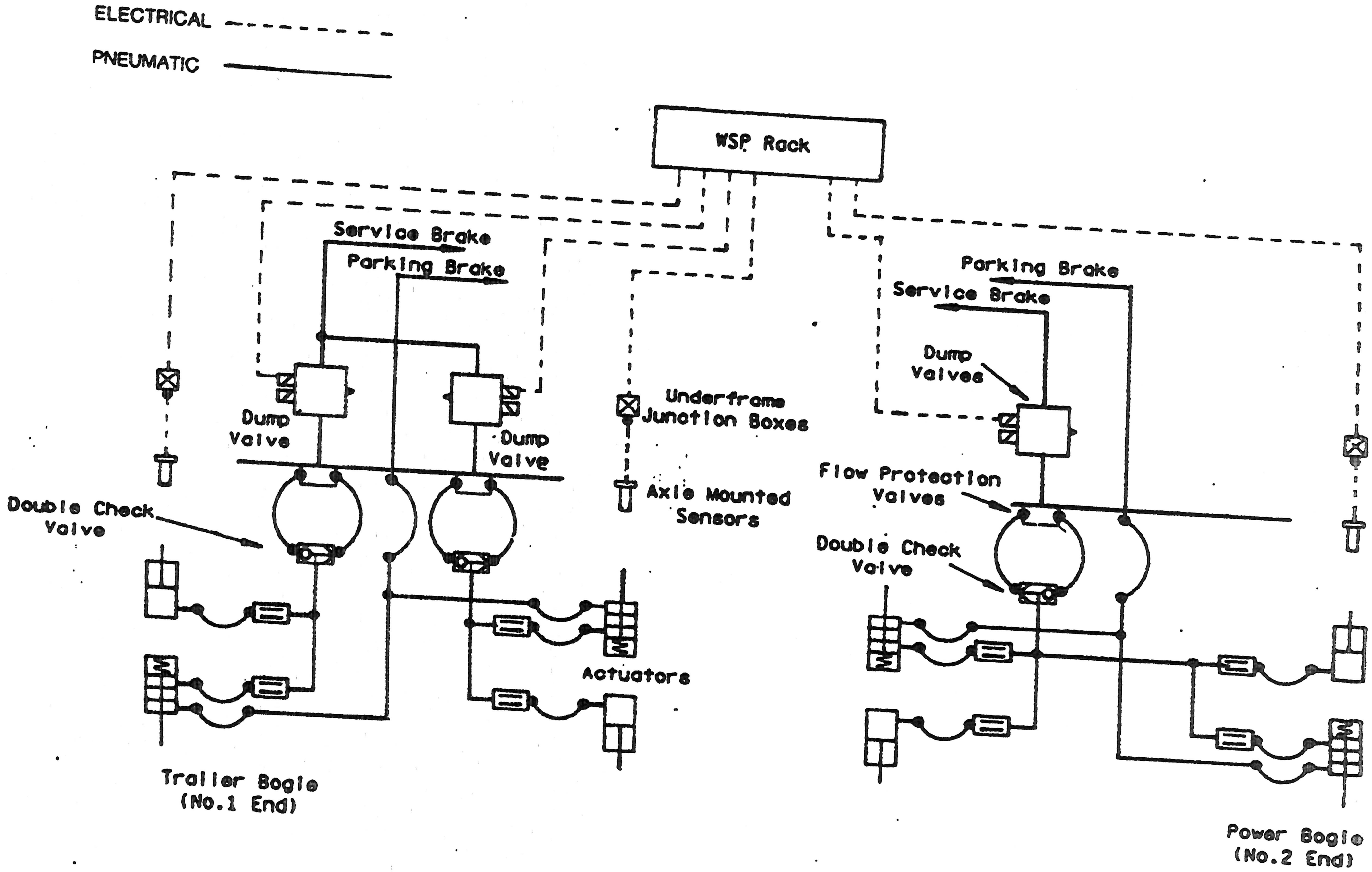
The 3 way cock (By-pass cock) is only used under certain emergency situations: On a vehicle with an inoperative air brake, the parking brake will automatically apply. The cock gives the train crew the opportunity to release the parking brake, provided the local main reservoir pipe is charged. The parking brake can be re-applied by returning the cock to its "normal" position, which vents the air from the parking brake air system.

The anti-compound valve (double check valve) interfaces the parking brake with the service brake to prevent compounding of the two systems at the brake cylinders. i.e. If the parking brake valve is de-energised with the service brake applied, air from the air brake will (via the anti-compound valve) be supplied to the parking brake system to hold the springs off.

The parking brake air feed now goes to the relevant brake cylinders. A parking brake pressure switch monitors the air pressure and via the fault indication circuit informs the driver whether the parking brake has been released.

BRAKE UNIT


STRAINER CHECK VALVE AND CHOKE
VARIABLE LOAD VALVE
RELAY VALVE
CHARGING VALVE
CHECK VALVES
TERMINAL BLOCK
PRESSURE REGULATOR
MRPIC
ASRIC
CGIC
BSRIC
MRFIC
BCIC
ASIC
ASIC (2)
TEST POINTS
V-CSU
V-EH
Dormant Service Brake
Dormant Parking Brake
Parking Brake.
LMRG
COMP GOV
BSR GOV
R-EBK2/1
R-EBK1/1
CHECK VALVES
TEST POINTS
E.P VALVES
DOUBLE CHECK VALVE
CHECK VALVE
RELAYS


ELECTRICAL
PNEUMATIC
WSP Rack
Service Brake
Parking Brake
Dump Valve
Dump Valve
Double Check Valve
Underframe Junction Boxes
Axle Mounted Sensors
Actuators
Trailer Bogie (No.1 End)
Parking Brake
Service Brake
Dump Valves
Flow Protection Valves
Double Check Valve
Power Bogie (No.2 End)

FRICTION BRAKE AND WSP EQUIPMENT

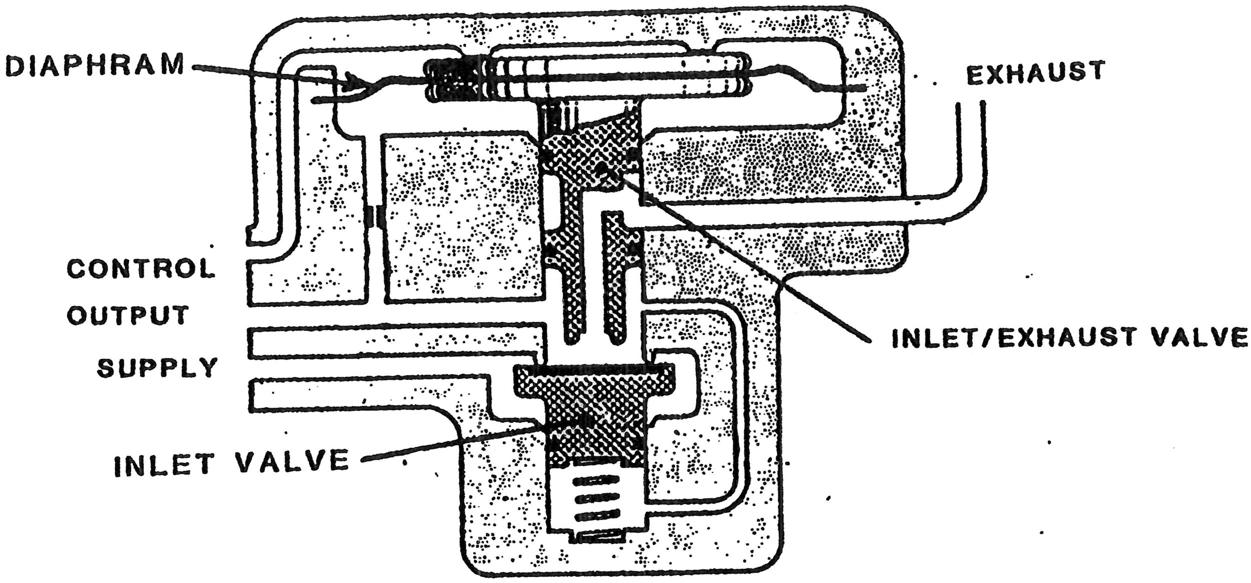
4. BRAKE EQUIPMENT

4.1 4 Step Relay Valve

4.1.1 Operation

In most traction applications a relay valve responds to a single control signal, as shown below.

SINGLE STAGE RELAY VALVE



On Class 165 there are effectively 4 possible control signals. These 4 are needed to give 3 equal steps of service braking and a higher brake force in an emergency.

To accommodate these extra control signals the number of control chambers has been increased. As there is now more than 1 control chamber, the force applied to the inlet/exhaust valve is transmitted by followers attached to each control chamber diaphragm.

When air pressure is applied to the Control Chamber with no output pressure, the diaphragm will force the inlet/exhaust valves downwards.

This movement closes the exhaust valve and opens the inlet valve, allowing air to pass from the supply to the output port:- applying the brakes.

A "feedback" signal is taken from the output port and applied to the underside of the diaphragm which causes it to "balance" when the output pressure reaches the correct level, closing the inlet valve but leaving the exhaust valve closed also.

This holds the required pressure in the cylinders and also automatically "tops up" the pressure as long as the control signal is present.

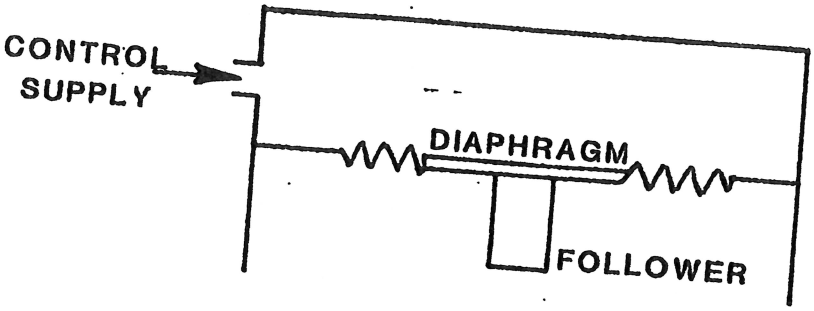
Removing the signal reverts the diaphragm to normal and allows the output (Brake cylinders) to exhaust closing off the supply.

The effect of air in a control chamber depends on its position in the valve as shown below.

a) Top Chamber

The force on the follower is directly related to diaphragm size and the control air pressure.

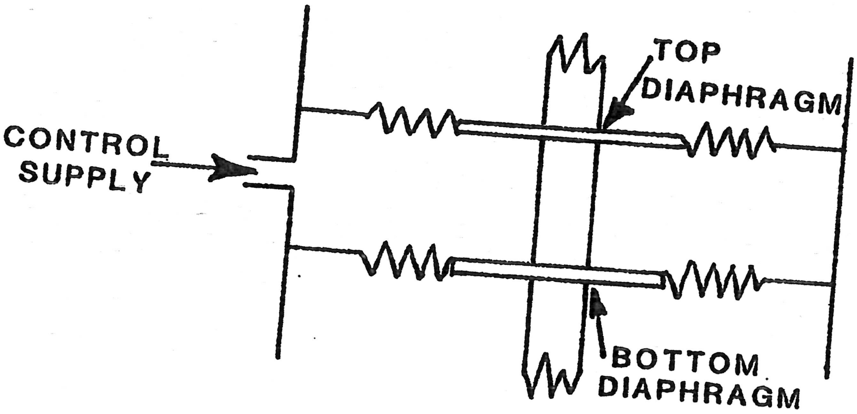
i.e. Diaphragm area 4 in
Control Pressure 10 p.s.i.
Force 4 x 10 = 40lb.


CONTROL
SUPPLY
DIAPHRAGM
FOLLOWER

b) Intermediate Chamber

The force on the follower from a control pressure is this chamber depends on the difference in size between the two diaphragms.

i.e. If top diaphragm is 4 in
bottom diaphragm is 6 in
control pressure is 10 p.s.i.


TOP
DIAPHRAGM
CONTROL
SUPPLY
BOTTOM
DIAPHRAGM

Force upwards on top diaphragm = 4x10 = 40lb
Force downwards on bottom diaphragm = 6x10 = 60lb

Net downward force on follower = 60 - 40 = 20lb

These features can be combined to produce a relay valve which gives 3 equal steps of output.

Basic Three Step Relay Valve

Area of diaphragm in chamber A = 2 units (say 2 ins)

Area of diaphragm in chamber B = 3 units (say 3 ins)

Control air signals are the same (say 10 p.s.i.)

Control signal into chamber B (only)

Upward force on top diaphragm = 2 units (10 x 2 = 20lb)

Force on bottom diaphragm = 3 units (10 x 3 = 30lb)

i.e. Net force applied to follower = 3 - 2 (30 - 20)

= 1 unit (= 10lb)

Control signal into chamber A (only)

Force down on diaphragm = 2 units (10 x 2 = 20lb)

There is no air in chamber B so

net force applied to follower = 2 units (= 20lb)

Control signal in chamber A & B

Force down on top diaphragm = 2 units (10 x 2 = 20lb)

Force up on top diaphragm = 2 units (10 x 2 = 20lb)

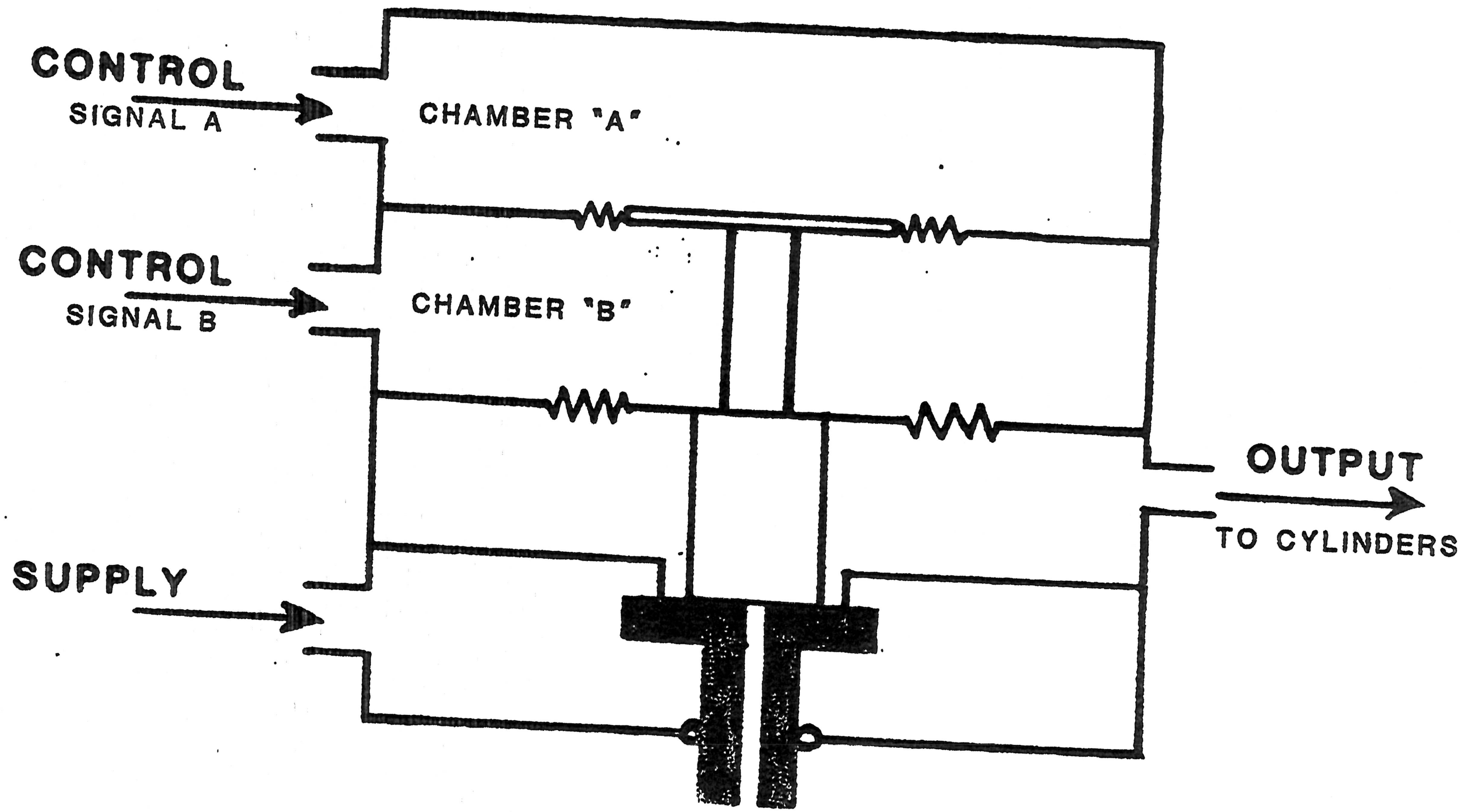
Force down on bottom diaphragm = 3 units (10 x 3 = 30lb)

i.e. net force down on follower = 2-2+3 (20-20+30)

= 3 units (= 30lb)

Thus we have 3 equal steps of output.

BASIC THREE STEP RELAY VALVE


CONTROL
SIGNAL A
CHAMBER "A"
CONTROL
SIGNAL B
CHAMBER "B"
SUPPLY
OUTPUT
TO CYLINDERS

On Class 165 this is the method by which 3 equal steps of service braking is achieved.

There are also some additional features in the Class 165 relay valve.

1. Emergency Brake - It has been decided that extra brake force will be available in emergency. This is provided by the addition of another control chamber at the top of the relay valve and an associated chamber open to atmosphere.

   The follower of the emergency diaphragm acts on the 3 step unit top diaphragm without being affected by any air pressure in the 3 step unit.

   The relay is called a "4 step" relay valve because of this emergency brake feature.

2. Brake Enhancement-Equipment losses in the brake equipment mean that the 3 step unit does not produce 3 equal steps of brake force at the wheel. This problem has been overcome by the addition of a further control chamber which adds a fixed amount of additional force to the follower, (the enhancement) whichever brake step is used. This extra force on the follower compensates for the rigging losses.

3. Safety - If there should be a failure of the registration diaphragm, the loss of air to atmosphere through the port in the chamber above, is so slow that the relay valve will continue perform as usual, except the brake cylinder pressure may be reduced slightly.

4.1.2 Pneumatic Control Signals

Air is admitted to the 4 control chambers by electro-pneumatic (e.p.) valves which form part of the relay valve assembly.

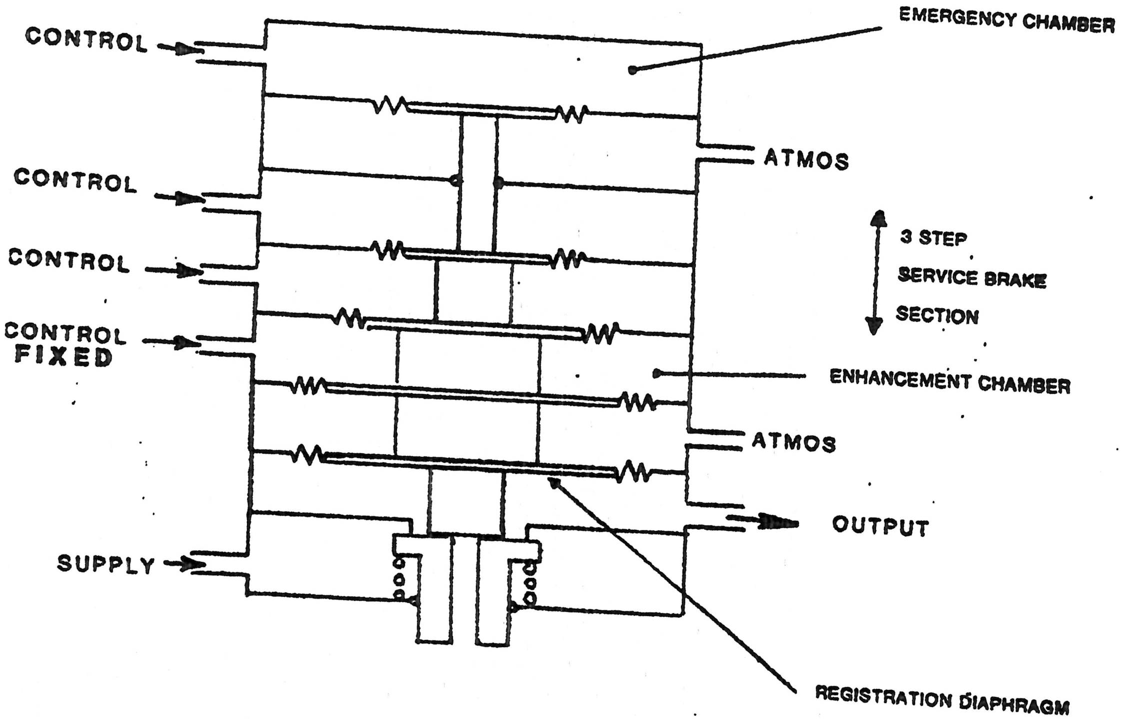
The connections to the e.p. valves are arranged so that when de-energised air enters the chambers, i.e. if there was a loss of electrical supply the relay valve would operate and the brakes would apply.

This is the feature that makes the Westcode system fail safe.

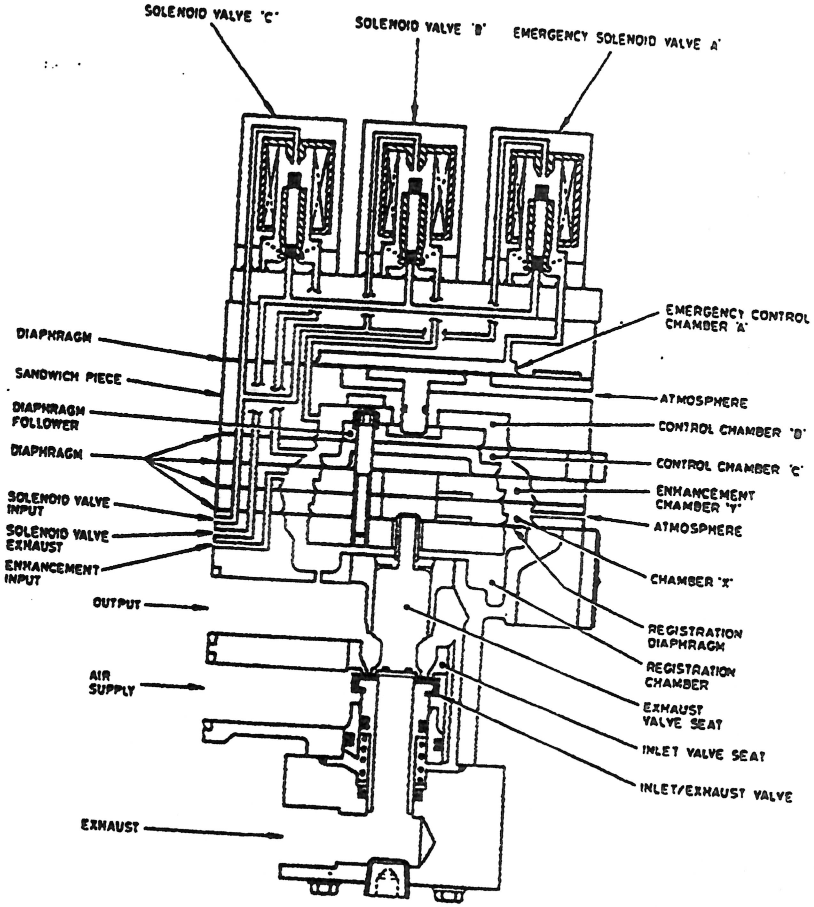
The control air is obtained from 2 sources:-

a) A variable load valve supplies the air pressure for the 3 step unit and emergency chamber, so that brake pressure is directly related to the weight of the vehicle.

b) The brake supply reservoir which provides the air pressure for the enhancement system. The reservoir pressure is maintained within close limits and so is a suitable source for the fixed enhancement signal.


CONTROL
CONTROL
CONTROL
CONTROL FIXED
SUPPLY
EMERGENCY CHAMBER
ATMOS
3 STEP SERVICE BRAKE SECTION
ENHANCEMENT CHAMBER
ATMOS
OUTPUT
REGISTRATION DIAPHRAGM

BASIC FOUR STEP RELAY VALVE


SOLENOID VALVE 'C'
SOLENOID VALVE 'B'
EMERGENCY SOLENOID VALVE 'A'
DIAPHRAGM
SANDWICH PIECE
DIAPHRAGM FOLLOWER
DIAPHRAGM
SOLENOID VALVE INPUT
SOLENOID VALVE EXHAUST
ENHANCEMENT INPUT
OUTPUT
AIR SUPPLY
EXHAUST
EMERGENCY CONTROL CHAMBER 'A'
ATMOSPHERE
CONTROL CHAMBER 'B'
CONTROL CHAMBER 'C'
ENHANCEMENT CHAMBER 'Y'
ATMOSPHERE
CHAMBER 'X'
REGISTRATION DIAPHRAGM
REGISTRATION CHAMBER
EXHAUST VALVE SEAT
INLET VALVE SEAT
INLET/EXHAUST VALVE

WESTINGHOUSE FOUR STEP RELAY VALVE

4.2 Variable Load Valve

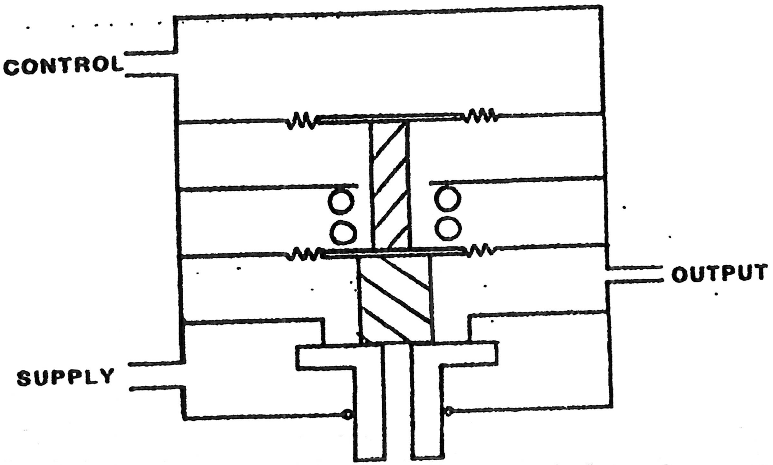
The variable load valve responds to an input from the air suspension system to provide a control air pressure to the 4 step relay valve that is proportional to the weight of the vehicle.

The principle of operation is similar to that of a two stage relay valve where one of the control air signals has been replaced by a spring.

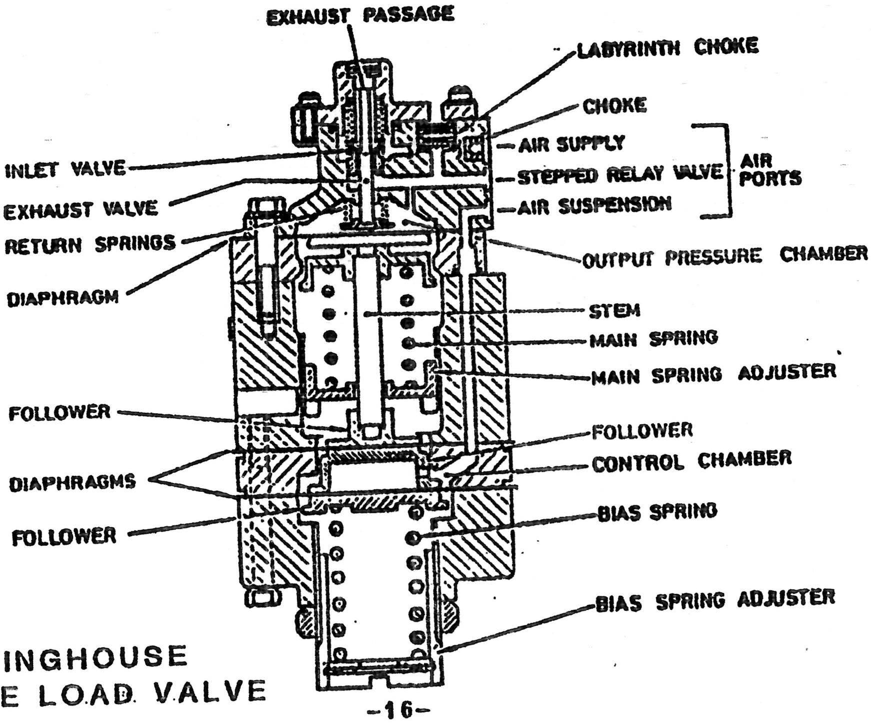
This spring is pre-adjusted for the vehicle concerned and exerts a force on its diaphragm follower that is proportional to the weight of the bogies. A control chamber supplied with air from air suspension system, then adds to the force on this follower an amount that is similarly proportional to the weight of the coach (vehicle bogies).

Thus the variable load valve will respond to changes in the coach weight, as passengers leave or join the vehicle, to give an output pressure proportional to the vehicle weight.

BASIC VARIABLE LOAD VALVE


CONTROL
OUTPUT
SUPPLY

The valve is supplied with air from the brake supply reservoir.


EXHAUST PASSAGE
LABYRINTH CHOKE
CHOKE
AIR SUPPLY
STEPPED RELAY VALVE
AIR SUSPENSION
AIR PORTS
INLET VALVE
EXHAUST VALVE
RETURN SPRINGS
DIAPHRAGM
OUTPUT PRESSURE CHAMBER
STEM
MAIN SPRING
MAIN SPRING ADJUSTER
FOLLOWER
FOLLOWER
CONTROL CHAMBER
DIAPHRAGMS
BIAS SPRING
FOLLOWER
BIAS SPRING ADJUSTER

WESTINGHOUSE
VARIABLE LOAD VALVE

The variable load valve used on the Class 165 has an additional spring, known as the bias spring, which acts through its diaphragm & follower, on the air suspension diaphragm. This spring is adjusted to exert the same force as a fully loaded coach. The spring is fitted as a safeguard and only becomes effective if the air signal from the secondary suspension is lost.

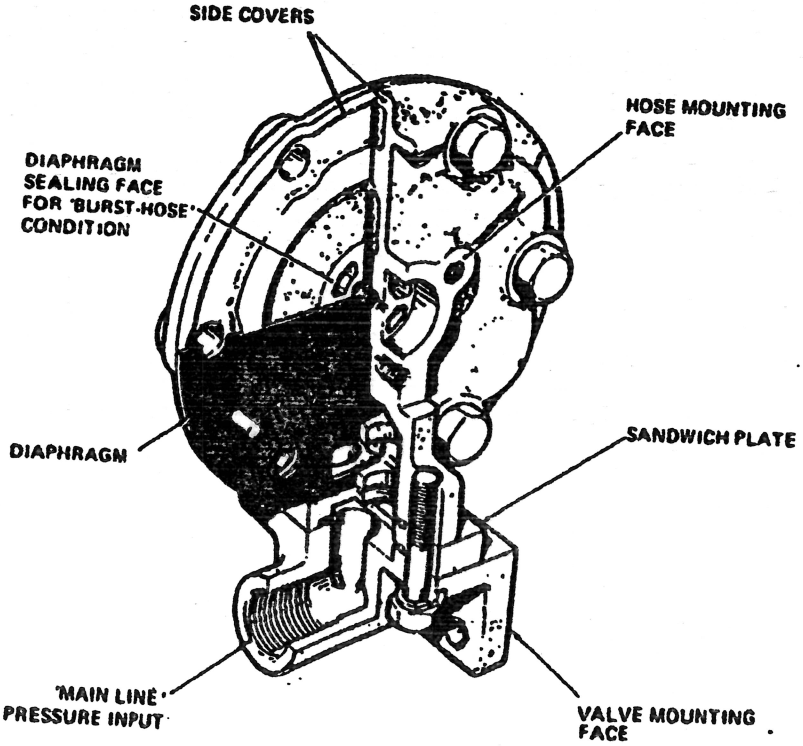
i.e. The bias spring will cause the variable load valve to give the fail-safe output of a fully loaded vehicle.

4.3 Flow Protection Valve

From the brake unit each bogie's brake air supply goes to an air-flow cut off valve, located on the underframe above the bogie. there are two independent hose connections from the valve to the bogie, one from each side of the valve diaphragm. On the bogie the hoses are connected to a double check valve. Brake cylinder pressure is fed through the valve via both sides of the diaphragm and out through the ported flat seats to the connecting hoses.

In the event of a burst hose the cut-off valve operates by the pressure loss on one side forcing the diaphragm onto the flat seat on the burst hose side of the valve thus sealing off the burst hose from the air supply. Full brake cylinder pressure is still fed via the other side of the diaphragm. The double check valve mounted on the bogie performs a similar operation, thus ensuring that both ends of the burst hose are sealed.

A small choke hole through the diaphragm centre permits sufficient air to pass to the hose rupture point to give audible indication of leakage. Upon rectification of the faulty hose, pressure is restored to both side of the diaphragm which is then repositioned centrally between the two side covers.


SIDE COVERS
HOSE MOUNTING FACE
DIAPHRAGM SEALING FACE FOR 'BURST-HOSE' CONDITION
DIAPHRAGM
SANDWICH PLATE
'MAIN LINE' PRESSURE INPUT
VALVE MOUNTING FACE

4.4 Brake Unit

4.5 Brake Cylinder Unit

Class 165 employ a disc braking system which uses S.A.B. type CAU2-190 actuators. These actuators are push - type units which incorporate automatic slack adjusters. There is 1 actuator per wheel and 1 per axle is a type CAU2-190S that incorporates a spring parking brake. The actuators apply a braking force by pushing a pair of brake pads onto wheel check discs with a calliper assembly.

Each actuator is air operated and controlled by the brake unit. The actuator mechanism consists of a support bracket, calliper assembly, two pad holders, two split disc pads and the brake actuator. Each disc pad comprises two halves which are fitted into dovetail slots in the pad holders and secured by retaining clips.

Each pad holder is secured to the support bracket with a single cotter pin, washer and split pin. The pads lining is provided with grooves machined into the surface to eliminate squeal and indicate wear.

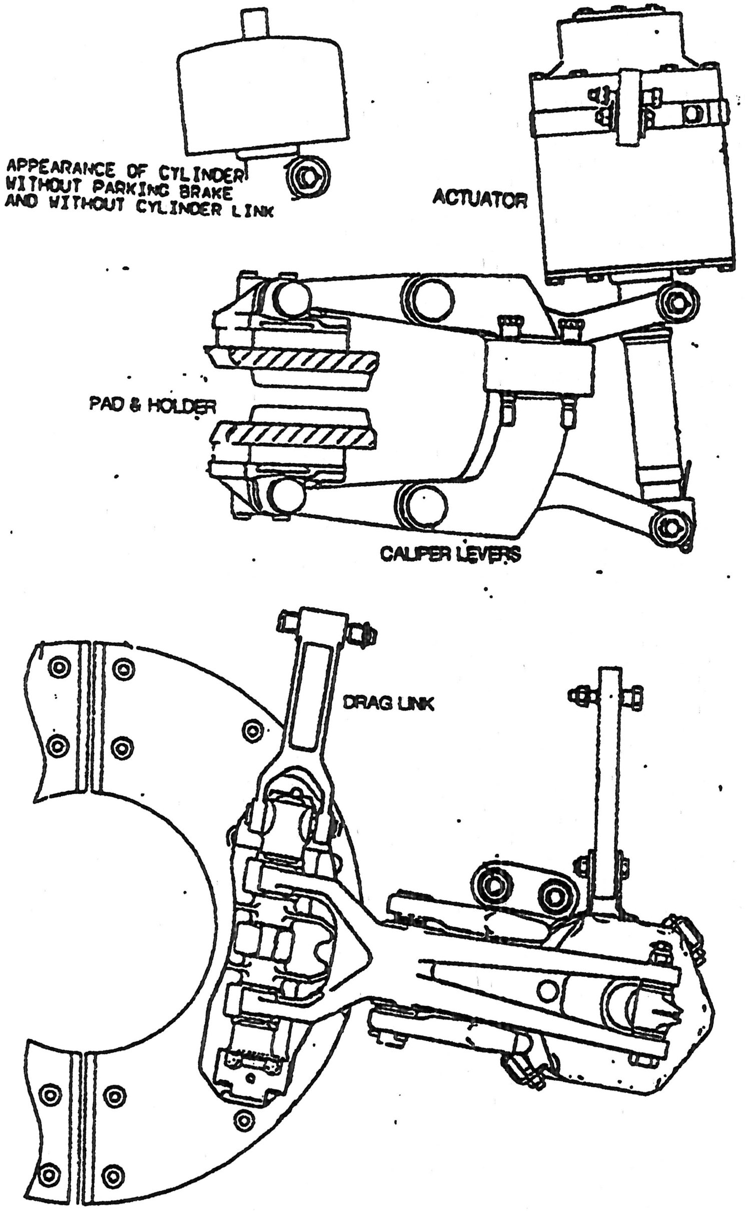
The pads are maintained in a constant position relative to the cheek discs by the calliper assembly and the automatic "true" slack adjuster. The slack adjuster is unaffected by vibration or calliper elasticity and is independent of piston stroke. e.g. If the callipers bend excessively causing the piston to travel almost its full stroke, the slack adjuster will not take up. However if the pad clearance exceeds the pre-set value the unit will sense this during the brake application and then reduce the clearance to its correct value on brake release. Pad clearance is pre-set during manufacture.

The spring applied units are held in the OFF position by air pressure obtained from the local main reservoir via the parking brake control system. If air pressure decreases, the parking brakes will be applied. The spring applied unit is equipped with a manual quick release feature (turn the release wheel with the correct tool) that will release the spring brake if air is not available. The spring unit cannot be re-applied manually, but automatically resets when air pressure is again available.

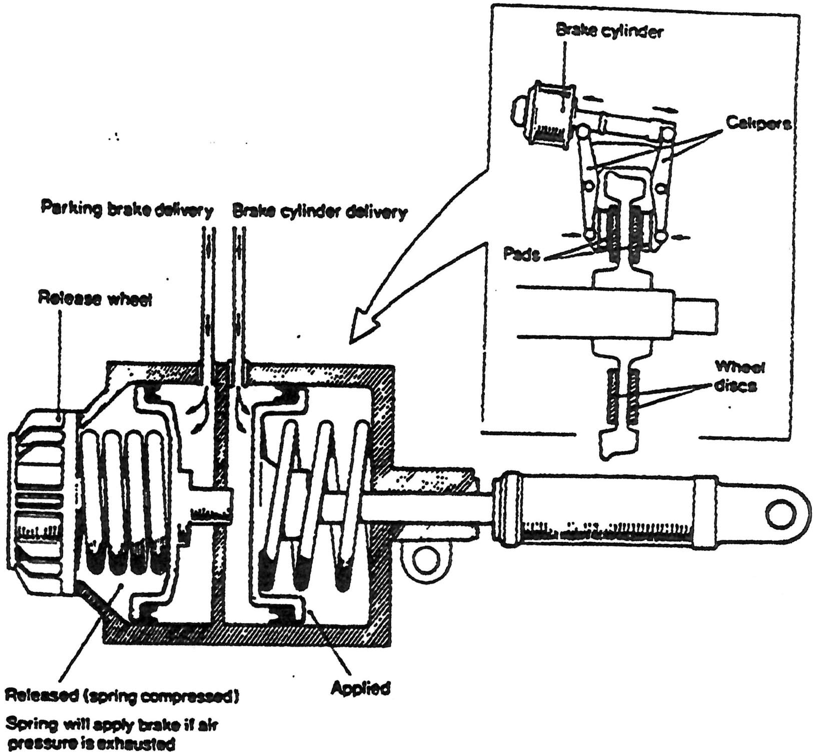
MAINTENANCE NOTES

THE SPRING APPLIED UNIT MUST NOT BE DISMANTLED. This should only be carried out after reference to the relevant manual at the approved repair centre.

When the pads are to be changed the pad clearance can be increased by disengaging the pin at the end of the actuator push rod and rotating the push rod sleeve in the appropriate direction.


APPEARANCE OF CYLINDER
WITHOUT PARKING BRAKE
AND WITHOUT CYLINDER LINK
ACTUATOR
PAD & HOLDER
CALIPER LEVERS
DRAG LINK

SERVICE BRAKE INSTALLATION


Brake cylinder
Calipers
Pads
Wheel discs
Parking brake delivery
Brake cylinder delivery
Release wheel
Released (spring compressed)
Spring will apply brake if air pressure is exhausted
Applied

CLASS 165 PARKING BRAKE CYLINDER

5. BRAKE CONTROL SYSTEM

5.1 General

Electrical control of braking enables simultaneous application and release of the air brakes on all vehicles in a formation.

To make the system fail-safe it must be an energise to release system. i.e. If the electric supply is lost the brakes apply. This feature allows numerous safety features to be built into the braking system.

The system used on Class 165 is the Westinghouse "Westcode" electro-pneumatic (e.p.) system.

Service braking is controlled by a combined power-brake controller which codes signals on 2 train wires to give 3 steps of braking. A third train wire is de-energised during emergency braking to give a 4th brake step. On each vehicle the train wires operate the e.p. valves on the relay valve to control the admission of air to the brake cylinders.

The electrical control system can be considered as working in 3 stages:-

a) Safety Checks

b) Train Wire Control

c) Response to Train Wire Signals

5.2 Safety System Checks

Certain conditions must be fulfilled before the 3 brake control train wires are energised to release the brakes

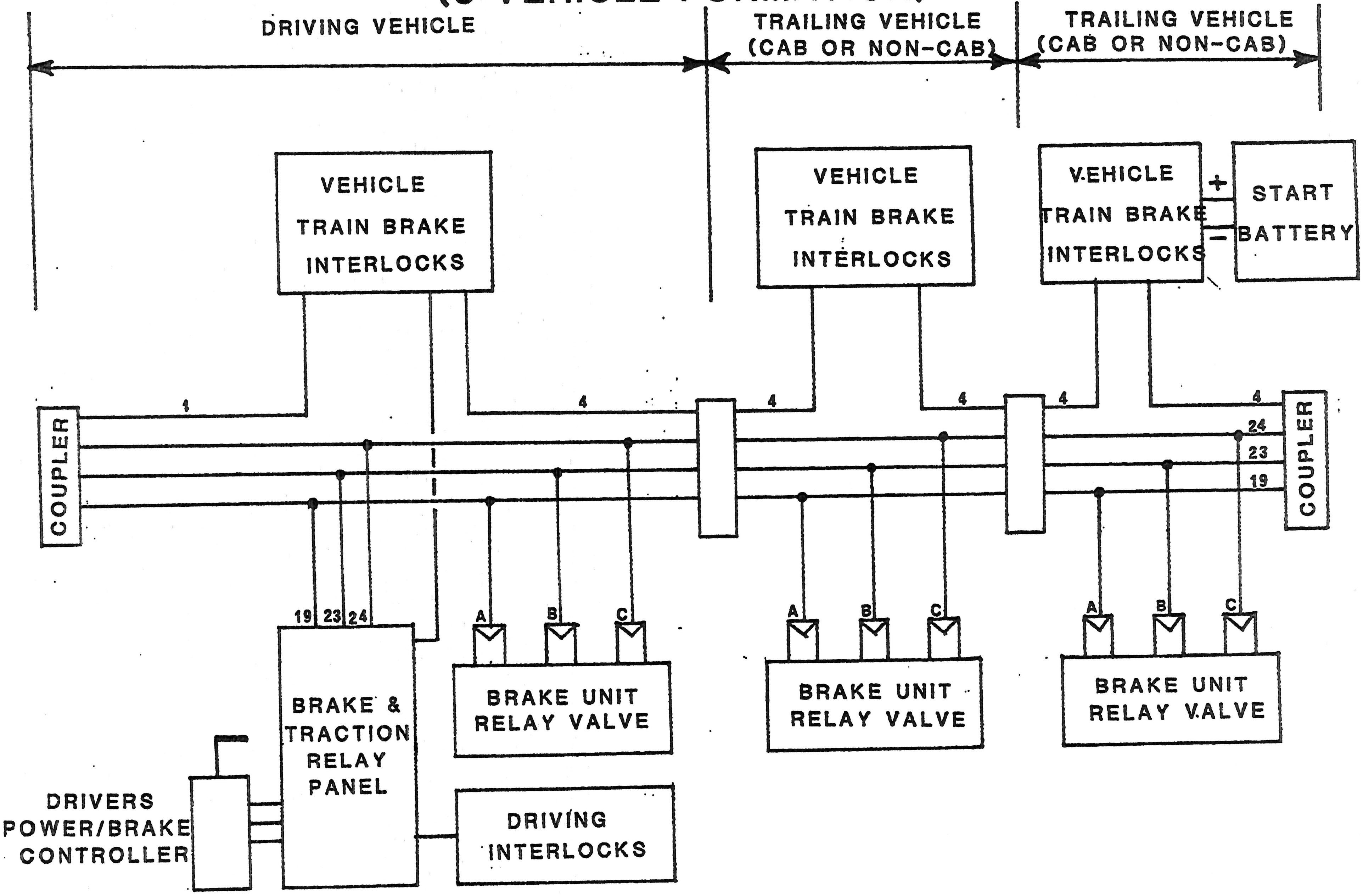
a) Train brake interlock circuit intact (wire 4)

b) Driving systems interlock circuitry

c) Drivers master switch away from "OFF"

d) None of drivers emergency brake controls operated.

BRAKE ELECTRICAL CONTROL SYSTEM
(3 VEHICLE FORMATION)


DRIVING VEHICLE
TRAILING VEHICLE (CAB OR NON-CAB)
TRAILING VEHICLE (CAB OR NON-CAB)
VEHICLE TRAIN BRAKE INTERLOCKS
VEHICLE TRAIN BRAKE INTERLOCKS
VEHICLE TRAIN BRAKE INTERLOCKS
+
−
START BATTERY
COUPLER
COUPLER
4
4
4
4
4
4
24
23
19
19
23
24
A
B
C
A
B
C
A
B
C
BRAKE & TRACTION RELAY PANEL
BRAKE UNIT RELAY VALVE
BRAKE UNIT RELAY VALVE
BRAKE UNIT RELAY VALVE
DRIVERS POWER/BRAKE CONTROLLER
DRIVING INTERLOCKS

5.2.1 Train Brake Interlock Circuit (Train wire 4)

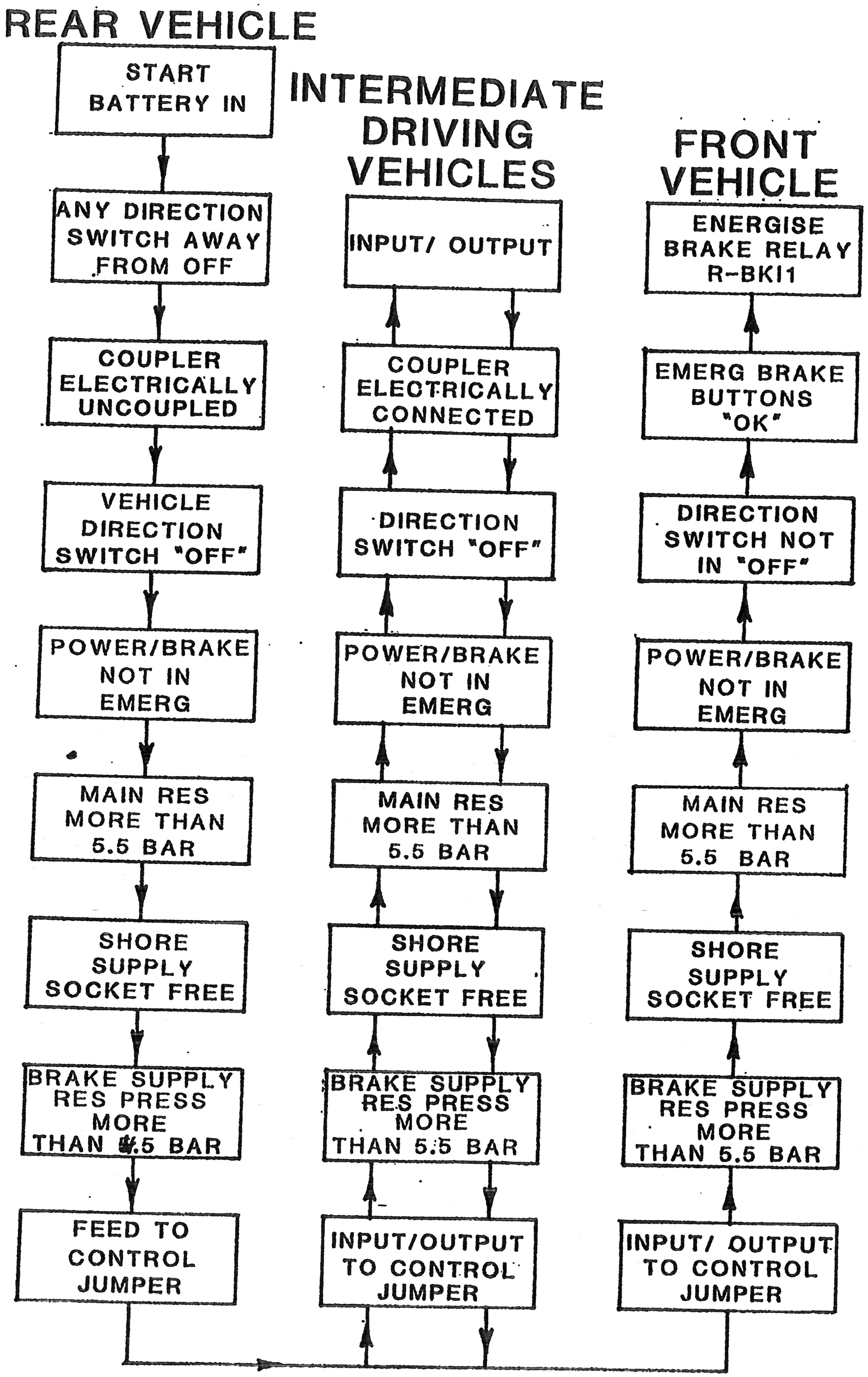
This circuit is fed from the rear of the train and if the relevant safety interlocks on each vehicle are made it allows operation of the brake relay R/BKI1 in the driving cab.

Normally the coupler at the rear of the train is in the un-couple position. This identifies where the rear of the train is and causes the "Start" Battery of that vehicle to supply the train brake interlock circuit. The interlock circuit checks on all vehicles:-

a)	Direction Switch in "OFF"	- except in driving cab - ensures only 1 driving position.
b)	Power/Brake controller not in emergency	- allows a person in a non-driven cab to give an emergency brake.
c)	Main reservoir pipe pressure more than 5.5 bar	- Checks the train has - not divided.
d)	Brake supply reservoir pressure more than 5.5 bar	- Checks sufficient brake air to stop vehicle.
e)	Shore supply socket not in use	- Prevents vehicle being driven with leads connected to socket.
f)	Electrical connection to adjacent vehicle(s)	- Checks formation intact

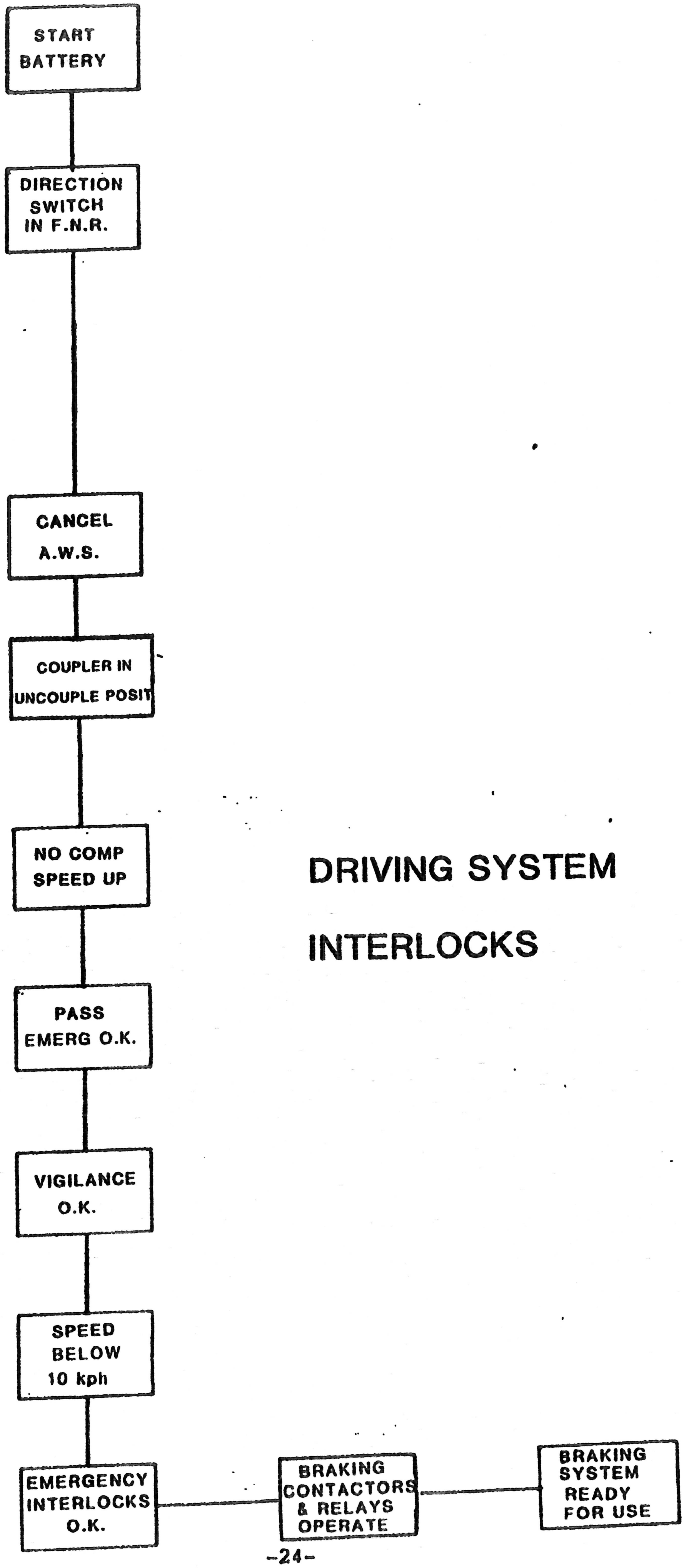
In the driving cab this circuit also checks the emergency brake push-buttons have not been operated and, when fitted, the Tripcock equipment (used on certain line only).

TRAIN BRAKE INTERLOCK CIRCUIT
(USUAL FORMATION)


REAR VEHICLE
START BATTERY IN
ANY DIRECTION SWITCH AWAY FROM OFF
COUPLER ELECTRICALLY UNCOUPLED
VEHICLE DIRECTION SWITCH "OFF"
POWER/BRAKE NOT IN EMERG
MAIN RES MORE THAN 5.5 BAR
SHORE SUPPLY SOCKET FREE
BRAKE SUPPLY RES PRESS MORE THAN 5.5 BAR
FEED TO CONTROL JUMPER
INTERMEDIATE DRIVING VEHICLES
INPUT/ OUTPUT
COUPLER ELECTRICALLY CONNECTED
DIRECTION SWITCH "OFF"
POWER/BRAKE NOT IN EMERG
MAIN RES MORE THAN 5.5 BAR
SHORE SUPPLY SOCKET FREE
BRAKE SUPPLY RES PRESS MORE THAN 5.5 BAR
INPUT/OUTPUT TO CONTROL JUMPER
FRONT VEHICLE
ENERGISE BRAKE RELAY R-BKI1
EMERG BRAKE BUTTONS "OK"
DIRECTION SWITCH NOT IN "OFF"
POWER/BRAKE NOT IN EMERG
MAIN RES MORE THAN 5.5 BAR
SHORE SUPPLY SOCKET FREE
BRAKE SUPPLY RES PRESS MORE THAN 5.5 BAR
INPUT/ OUTPUT TO CONTROL JUMPER

DRIVING SYSTEM

INTERLOCKS


START BATTERY
DIRECTION SWITCH IN F.N.R.
CANCEL A.W.S.
COUPLER IN UNCOUPLE POSIT
NO COMP SPEED UP
PASS EMERG O.K.
VIGILANCE O.K.
SPEED BELOW 10 kph
EMERGENCY INTERLOCKS O.K.
BRAKING CONTACTORS & RELAYS OPERATE
BRAKING SYSTEM READY FOR USE

5.2.2 Driving Systems Interlock Circuit

This interlock circuit checks the various driving system that can apply the brake.

The power supply for this circuit is obtained from the "start" battery on the leading vehicle, identified by its coupler being uncoupled. At this stage the circuit also checks the tripcock (where fitted) in the leading vehicle. The interlock circuit will then check the Train Brake Interlock system of all vehicles forward of the driven cab, as necessary, before checking the systems in the driving cab. The driven cab is identified by its Direction Switch being away from "OFF".

The systems checked are:-

a) D.S.D.

b) A.W.S.

c) Compressor Speed Up - not permitted as prevent detection of low main reservoir pipe pressure.

d) Passenger Emergency

e) Vigilance

f) Traction Interlock if speed above 10 kph - i.e. doors closed

g) Automatic Train Protection (A.T.P.) where fitted.

If these systems are satisfactory and the Train Brake Interlock circuit is intact relay R-BKI2 will be operated.

5.2.3 Drivers Emergency Brake Control Unit

In the driving cab the driver may make an emergency brake application by

a) Moving power/brake controller to emergency.

b) Operating one of the two emergency brake push-buttons.

If none of those actions has been made, and the driving systems are satisfactory, contactor C-BKE2 will operate.

5.2.4 Summary of Interlock Action

Train Brake Interlock Circuit O'K	Relay R-BKI1 energised
Driving Systems Interlock Circuits O'K + R-BKI1	Relay R-BKI2 energised
Drivers Emergency Brake Controls Normal + R-BKI2	Contactor C-BKE2 energised

If all the systems are satisfactory it is possible to release the brakes using the power/brake controller.

Relays R-BKI1 & R-BKI2 and the contactor C-BKE2 cause other relays & contactors to operate, which in turn de-earth the brake control wires and provide a supply to the brake side of the power/brake controller.

N.B. If any of the interlock circuits are broken this will de-energise the brake control train wires to give an emergency brake application.

5.2.5 Emergency Brake Isolation Switch

An emergency brake isolation switch is provided to enable trains to be moved if the train brake interlock circuit has been broken (except for opening of the main reservoir governor on the driving vehicle).

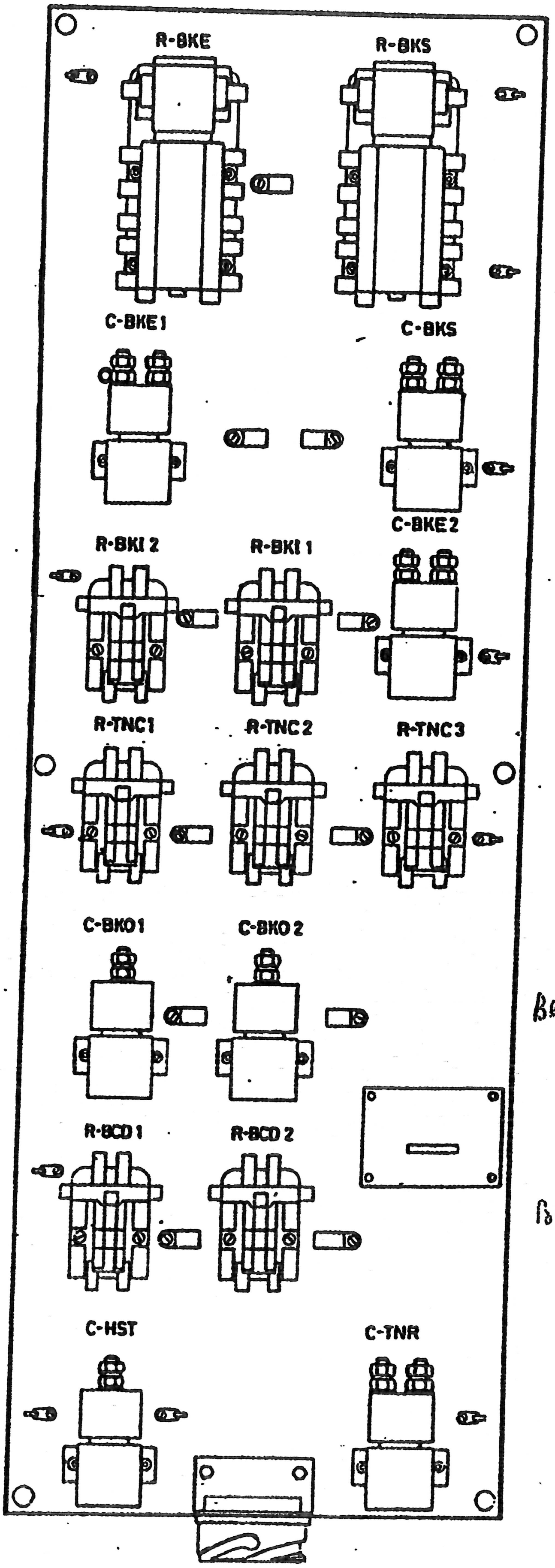
Operation of this switch and any subsequent train movements must be in accordance with local Operating Instructions.

If the cause of an emergency brake application is not easily identified Relay R-BKI1 on the Westinghouse brake panel will indicate the condition of the train brake interlock circuit.

5.3 Train Wire Control

With a satisfactory safety system check the power-brake control controller can be used to control the braking relays and contactors that control the energisation of the train wires to give various steps of braking on each vehicle.

BRAKE AND TRACTION RELAY PANEL


R-BKE
R-BKS
C-BKE1
C-BKS
C-BKE2
R-BKI 2
R-BKI 1
R-TNC1
R-TNC2
R-TNC3
C-BKO1
C-BKO2
R-BCD1
R-BCD2
C-HST
C-TNR

Traction coding

Brake off.

Brake coding

5.3.1 Power/Brake Controller

The Westinghouse BT 10 drivers power/brake controller is a manually operated cam switch unit that uses 4 cams to operate 3 groups of electrical contacts. The spring loaded handle of the controller has a movement of 78°, 36° in the forward direction covering the step 1, step 2, step 3 and Emergency brake positions, OFF is 10° from the vertical back towards the driver, the remaining 42° covers the 7 traction notches.

In the braking range, movement of the controller can operate

a) Two snap action movement CO-PB 1 & 2
b) Two heavy duty switches CO-PB 4 & 5
c) The heavy duty switch CO-PB 3 that energises the emergency train wire.
d) The heavy duty switch CO-PB6 that connects the brake and control negatives.

Operation of the push-button in the controller handle energises the hill-start contactor to give a step 1 brake up to 10 kph whilst taking power. Except in the Emergency position the heavy duty switches are all closed to energise the emergency train wire and allow the snap action switches to control the service brake.

5.3.2 Train Wire Signals

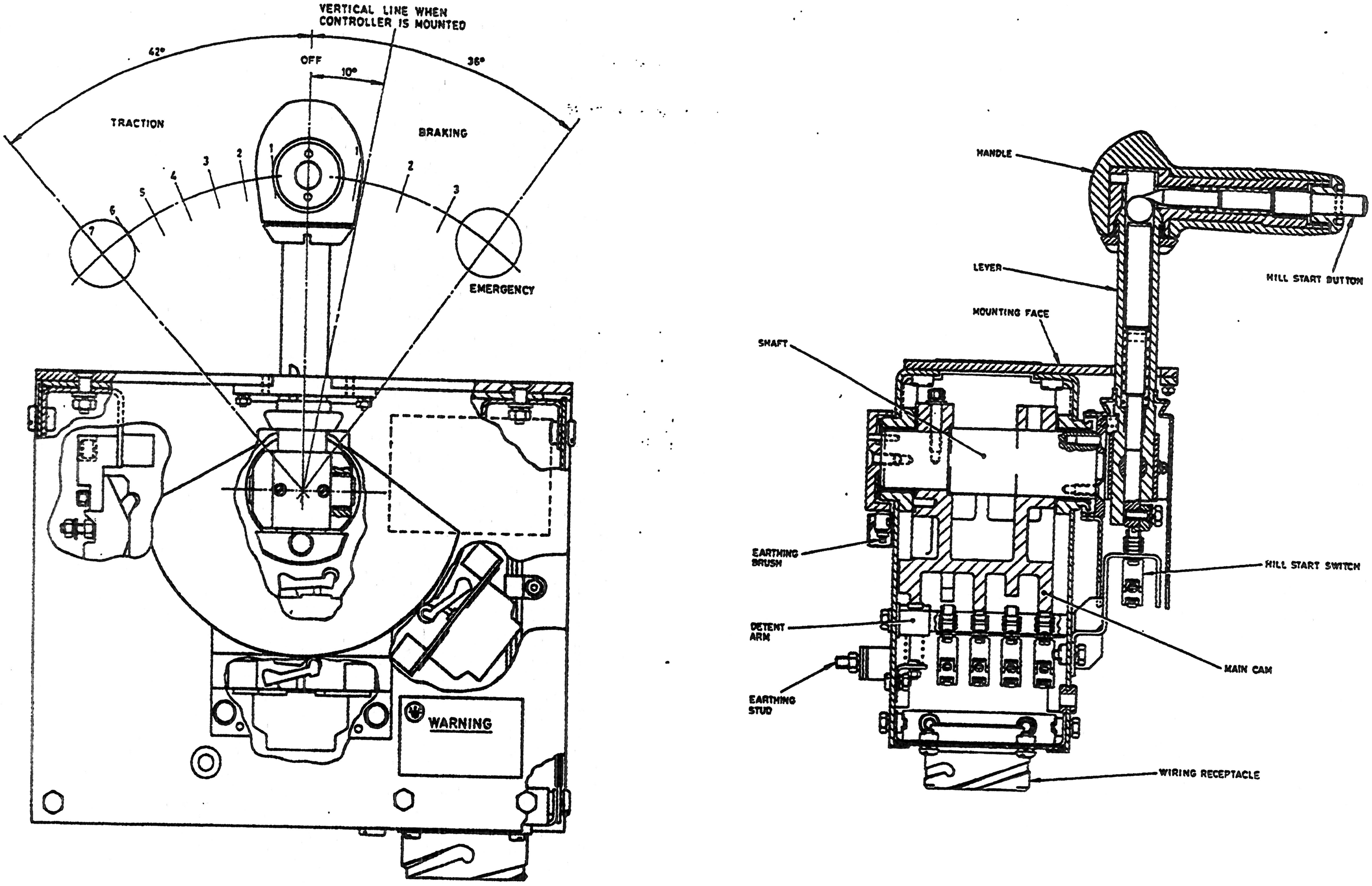
On Class 165 the service brake train wires are not directly switched by the power/brake controller, probably because of the high currents that would be repeatedly interrupted. Instead, the snap action switches control the operation of 2 brake relays R-BCD1 and R-BCD2. Contacts of these relays control the operation of two contactors C-BK01 and C-BK02 which energise train wire 23 & 24 to control the service brake.

The hillstart contact also operates a contactor C-HST that switches 23 train wire provided the speed is below 10 kph, Train wire 19, the emergency wire is energised directly from the controller, except when it is moved to the emergency position.

The switching of the relays and contactors controls the energisation of the train wires as follows

Power/Brake Controller Position	RELAYS		CONTACTORS			TRAIN WIRES		
	R-BCD1	R-BCD2	C-BK02	C-BK02	C-HST	23	24	19
HILLSTART	O	X	X	X	X	O	X	X
OFF	O	X	X	X	O	X	X	X
STEP 1	X	X	O	X	O	O	X	X
STEP 2	X	O	X	O	O	X	O	X
STEP 3	O	O	O	O	O	O	O	X
EMERGENCY	O	O	O	O	O	O	O	O

O = DE-ENERGISED X = ENERGISED.


VERTICAL LINE WHEN CONTROLLER IS MOUNTED
42°
OFF
10°
36°
TRACTION
BRAKING
1
2
3
4
5
6
7
1
2
3
EMERGENCY
WARNING
HANDLE
LEVER
MOUNTING FACE
SHAFT
HILL START BUTTON
EARTHING BRUSH
HILL START SWITCH
DETENT ARM
MAIN CAM
EARTHING STUD
WIRING RECEPTACLE

POWER/BRAKE CONTROLLER

6. AUTOMATIC WARNING SYSTEM (A.W.S.)

Class 165 is equipped with standard (modern) A.W.S. equipment which operates in the conventional manner.

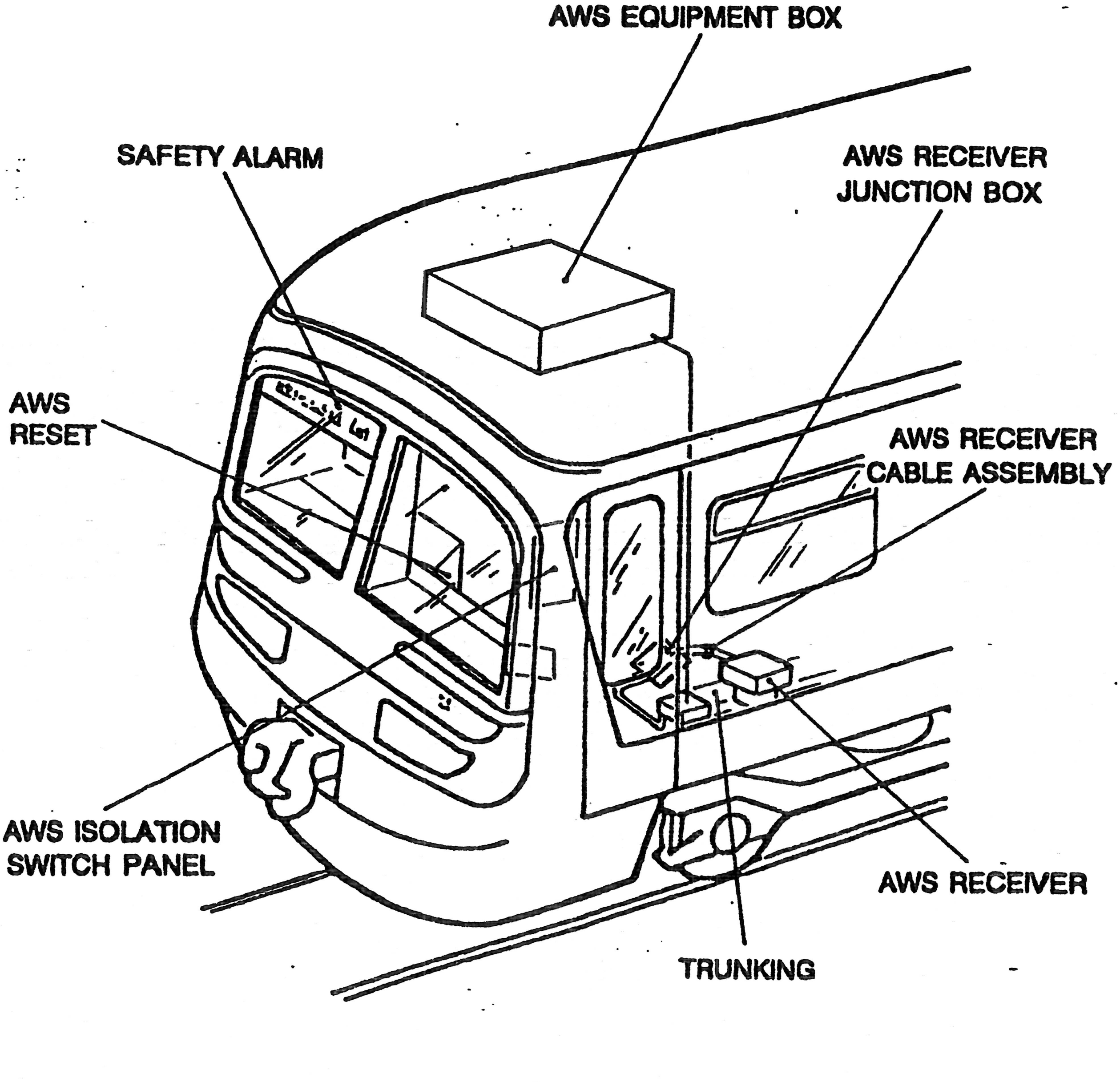
A Brake and Horn relay unit is provided to give brake applications and Horn/Reset functions when required.

Visual and audible cab indications are given by an Alarm indicator unit situated in front of the driver.

The majority of A.W.S. modules are situated in the cab roof.

A switch is provided on the isolation panel to isolate a defective system. This illuminates the mauve light on the destination indicator to provide an external indication that a safety system has been isolated.

AWS EQUIPMENT INSTALLATION


AWS EQUIPMENT BOX
SAFETY ALARM
AWS RECEIVER JUNCTION BOX
AWS RESET
AWS RECEIVER CABLE ASSEMBLY
AWS ISOLATION SWITCH PANEL
AWS RECEIVER
TRUNKING

7. DSD VIGILANCE SYSTEM

The DSD/Vigilance System is employed to ensure that the driver remains alert whilst he is in a position to control the train. It achieves this by monitoring changes in the state of resettable inputs:- DSD pedal, Direction Switch, Power/Brake Controller and the AWS caution acknowledgement.

The DSD pedal must be kept depressed in order for the train to be operated. Releasing the DSD pedal will cause the DSD buzzer to sound and after 5 seconds initiate an emergency brake application.

The DSD Vigilance unit must be reset every 60 seconds (the delay time) or else the DSD buzzer will sound. The DSD pedal must now be released and re-depressed within 5 seconds. If during the delay time the DSD Vigilance Unit detects a change of state of any of the resettable inputs then the 60 second delay time will be automatically reset and its countdown recommenced without the DSD buzzer sounding.

If the system is not reset an emergency brake application occurs. Failure to reset the system for a further 60 seconds causes a radio signal to be transmitted to the signalbox advising that the driver is incapacitated.

Even if a reset was made, it will not be possible to release the brakes until the speed is below 6 k.p.h.

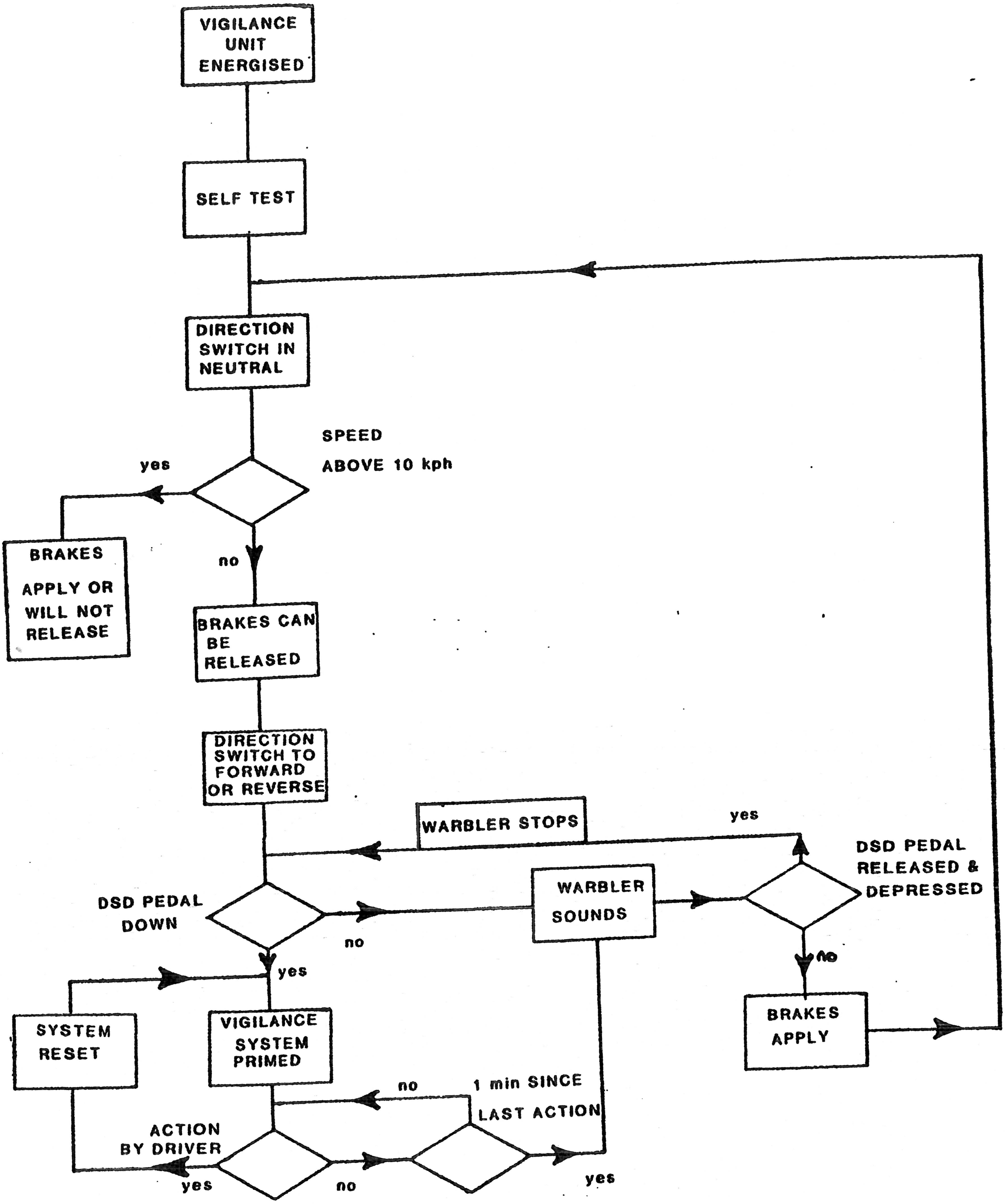
The DSD buzzer only sounds in the cab in which the driving key has been inserted, and is only operational when Forward/Reverse has been selected.

"Holdover" buttons are provided for use by the driver as an alternative to the DSD pedal when necessary.

If the DSD Vigilance unit fails the DSD buzzer sounds continuously. Confirmation of this failure is obtained by checking the LED's on the front of the Vigilance Unit (in the cab route). The green LED should be illuminated if the unit is working satisfactorily (i.e. Power On, Direction Switch in F or R and no fault in vigilance unit). The Vigilance unit carries out a Self Tests Routines when switched on and also continuously. When a test detects a fault the yellow L.E.D. illuminates, the buzzer sounds and the emergency brakes apply. If there is a transient fault the unit will automatically reset in about 4 seconds but the buzzer will still sound and the emergency brake apply. When the unit has reset the driver will need to reprime the system. If the fault persists operation of the Vigilance Isolation Switch allows the train to complete its journey. The DSD buzzer does not sound, but the DSD pedal must still be depressed in the Forward/Reverse position otherwise the DSD circuit will apply the brakes.

If the DSD system becomes defective it can be isolated using the DSD isolation switch to enable the brakes to be released.

NOTE: After operating any safety system isolation switch, the relevant local instruction must be followed before allowing any train movements.


VIGILANCE UNIT ENERGISED
SELF TEST
DIRECTION SWITCH IN NEUTRAL
SPEED ABOVE 10 kph
yes
BRAKES APPLY OR WILL NOT RELEASE
no
BRAKES CAN BE RELEASED
DIRECTION SWITCH TO FORWARD OR REVERSE
WARBLER STOPS
yes
DSD PEDAL RELEASED & DEPRESSED
DSD PEDAL DOWN
WARBLER SOUNDS
no
no
yes
SYSTEM RESET
VIGILANCE SYSTEM PRIMED
BRAKES APPLY
no
1 min SINCE LAST ACTION
ACTION BY DRIVER
yes
no
yes